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TECHNOLOGY UTILIZATION

VALVE TECHNOLOGY

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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TECHNOLOGY UTILIZATION OFFICE 1970
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Foreword

The National Aeronautics and Space Administration and the Atomic Energy Commission have established a Technology Utilization Program for the rapid dissemination of information on technological developments which have potential utility outside the aerospace and nuclear communities. By encouraging multiple application of the results of their research and development, NASA and AEC earn for the public an increased return on the investment in aerospace and nuclear research and development programs.

This publication is part of a series intended to provide such technical information. It presents technological advances of potential use in the petrochemical, food processing, pharmaceutical, plastics, electronics and automotive industries. Other subjects covered include energy absorption, pressure and temperature sealing, air conditioning, freeze drying and storage, and basic research and development in the area of calibration.

Additional technical information on individual devices and techniques can be requested by circling the appropriate number on the Reader's Service Card included in this compilation.

Unless otherwise stated, NASA and AEC contemplate no patent action on the technology described.

We always appreciate comment by readers and welcome hearing about the relevance and utility of the information in this compilation.

Ronald J. Philips, *Director*
Technology Utilization Office
National Aeronautics and Space Administration

Contents

Section 1. Relief Valves

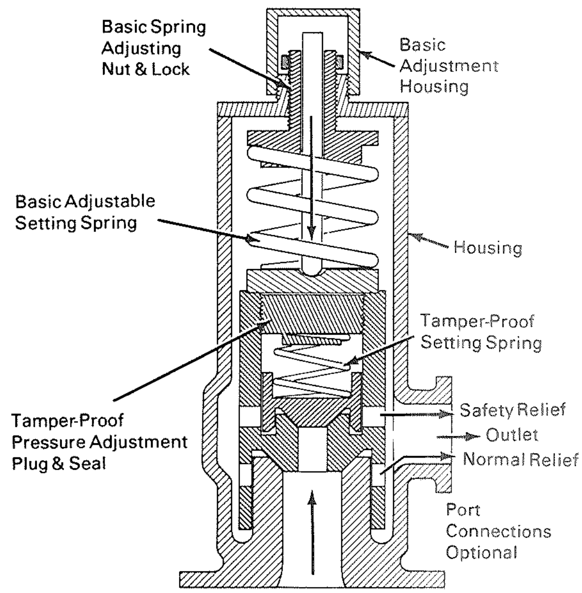
TAMPER-PROOF SAFETY RELIEF VALVE: A CONCEPT

Although still at the conceptual stage, specifications indicate this tamper-proof relief valve could take over in the event that a basic relief valve failed to open.

The capability of protecting a piping system from over-pressure by providing added safety relief through constant component operation should be of broad interest to the piping industry. Specific applications can readily be found in boiler, hydraulic, and chemical processing systems and various pneumatic systems.

Another potential advantage of this valve is that it can be manufactured from ferrous or nonferrous metals, plastics, synthetics or any combination of these materials to adapt to the user's specific application.

A close look at the subject innovation shows it to consist of a secondary spring valve, located internally in the main valve (see fig.) and set to relieve it at a slightly higher pressure than the latter. In a 100-psi system, for example, the basic relief valve is set to open at a cracking pressure of 110 psi. In the event that the basic relief valve will not function, (due possibly to over-tightening of the adjustable setting spring), and the system exceeds 125 psi, the safety relief valve then opens to relieve over-pressure. The adjustment of the basic relief valve is provided for by removing the seal wire and adjusting tension on the main spring; the tamper-proof element of the valve cannot be adjusted without major disassembly. Use of Type 316 stainless steel for the mechanical parts of this tamper-proof safety relief valve should reflect a reduction in manufacturing cost.



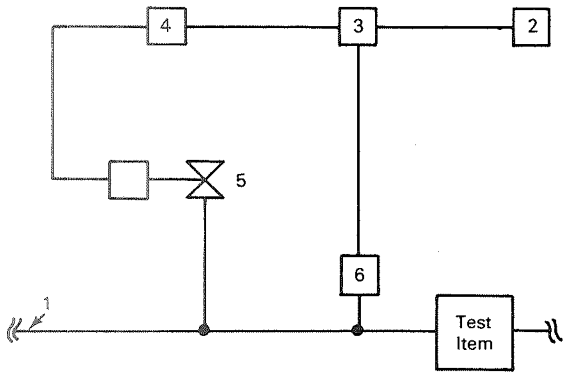
Source: Peter A. Frankewich of
Catalytic-Dow Co.
under contract to
Kennedy Space Center
(KSC-10470)

Circle 1 on Reader's Service Card.

QUICKLY ADJUSTED RELIEF VALVES

The subject disclosure relates to a relief valve which can provide protection for tested hardware at the maximum rated pressure of the hardware, in eight test cells involving 75 different settings. Such a valve should find ready use in any industrial piping system where maximum pressure is subject to frequent change; i.e., where several relief valves must be serviced and changed as required to provide over-pressure protection for all system components.

The solution to the problem entails the use of the following hardware: (1) a standard pressure transducer with a usable range at least equal to the desired pressure setting range; (2) standard electronics to receive the transducer output signal and convert it into a usable voltage output at piping system pressures above a variable but preselected pressure; and (3) an electrical or electromechanically controlled valve which opens on receipt of the electronic output signal. The pressure relief



1 Line to be Protected from Over Pressure

2 Pre-Selected Voltage, Proportional to Desired Relief Pressure.

3 Voltage Comparator & Output Signal Source & Control.

4 Control Device for Item 5 (Solenoid, Solenoid Valve, etc., as Applicable.)

5 Mechanical or Electro-Mechanical Valve for Pressure Relief.

6 Standard Pressure Transducer, Having Usable Range Equal to or Exceeding Desired Pressure Setting Range.

valve (item 5, block diagram) is controlled by a potentiometer dial, so that it can be activated to any desired setting. This rapidly adjusted relief valve can function without verification of each setting, except during periodic system calibration. No such system currently is manufactured.

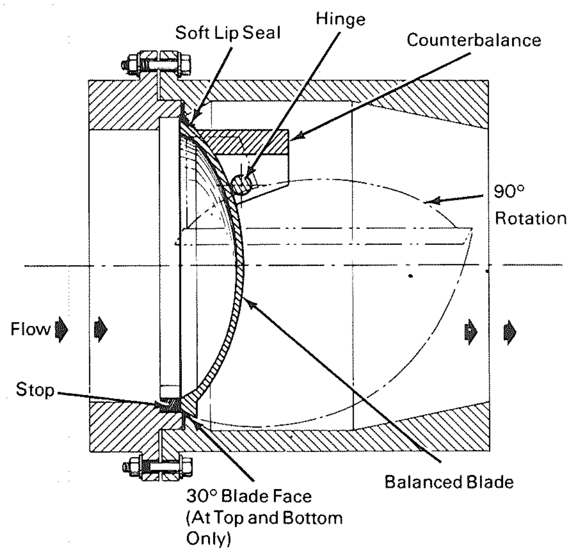
Source: W.S. Ross of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-18046)

No further documentation is available.

Section 2. Cryogenic Applications

CRYOGENIC CHECK VALVE: A CONCEPT

A concept has been evolved for a cryogenic check valve which could achieve maximum structural integrity, smooth fluid flow, and environmental compatibility. Included among its features would be (1) low cracking pressure for opening in the flow direction; (2) low backflow pressure for sealing in the closed position; (3) the ability to withstand high vibration loads without permanent damage; and (4) a capability of functioning both at extremely high and very low (cryogenic fluid) temperatures. The way now appears open to produce check valves of this design in a wide range of sizes and these should prove competitive for future marketing in areas such as air-conditioning, food-freezing, freeze-drying, and cold storage plants. Further, the potential benefits which would result from implementing the proposed conceptual scheme represent an advance in check valve technology.



Conventional large check valves that use line pressure to open the valve normally employ a sliding poppet or swing gate to minimize opening pressure. However, such devices function with a heavy mass/low spring rate system susceptible to vibration damage. In addition, the gravitational force of the heavy poppet valve alters initial cracking pressure. Another disadvantage of the conventional check valve is the relatively low temperature band in which it can operate.

The geometry of the balanced-blade soft-lip-seal check valve (see fig.) permits free rotation of the blade into or away from the seal over a wide range of environmental fluid temperatures. Seal scuffing and wear are eliminated, while the sealing quality of the lip seal improves as backflow pressure is increased.

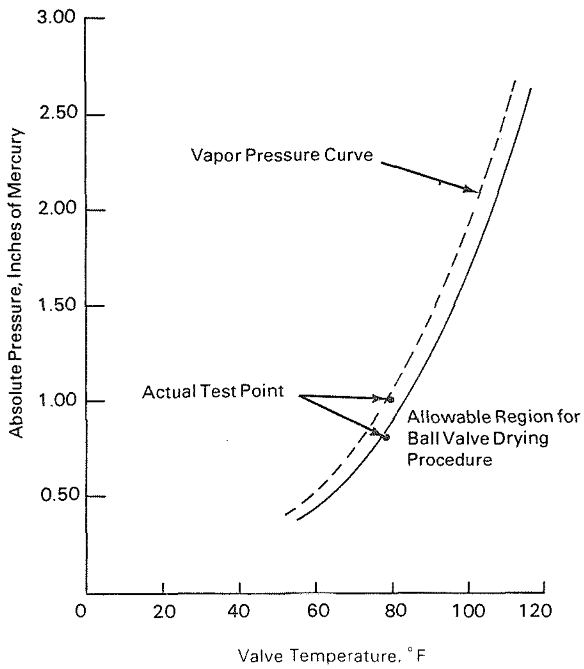
The location of the blade's turning axis in the flow stream permits an adequate unbalanced pressure force for extreme low pressure cracking (0.15 psig) to open the valve, and low back pressure for sealing. A counterbalance also is provided along the axis passing through the blade's centroid and turning axis. Thus, mass turning movements are balanced to zero. Forces caused by valve orientation that would normally rotate the blade and change minimum cracking pressure are excluded. Special tooling is required to machine the plastic seal and blade, but the cost is not prohibitive.

Source: R.F. Gilmore of
Chrysler Corp.
under contract to
Marshall Space Flight Center
(MFS-13044)

No further documentation is available.

CRYOGENIC VALVE DRYING PROCEDURE

A vacuum process for drying valves used in the transfer of cryogenics has potential application in a number of industries, particularly in freezing plants. This process, which meets a long standing requirement, ensures the removal of all moisture from critical areas in control valves subjected to cryogenic fluids. In the past, moisture control has been accomplished by heating—a method both costly and inadequate, since the time required for drying a given component at a specific temperature is difficult to judge. Further, there is no certainty that all traces of moisture have been removed from hidden traps.



In the new process, when a valve is exposed to low temperature flow, the resultant moisture or condensation is removed by a vacuum operating below the vapor pressure of the accumulated water.

The figure shows ball valve drying procedure in terms of absolute pressure against valve temperature in degrees F.

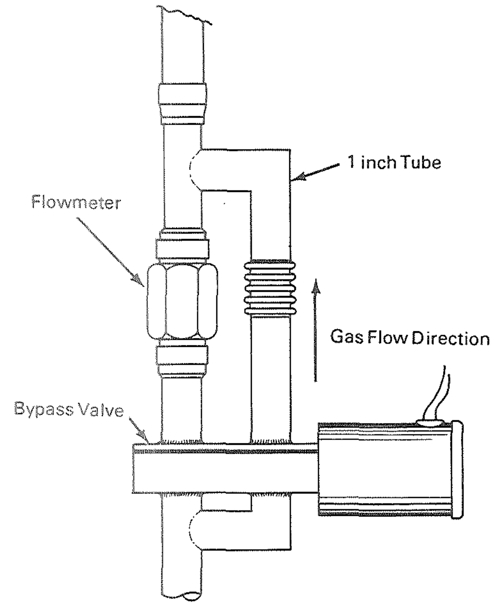
Source: G. Mirliss of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14097)

Circle 2 on Reader's Service Card.

FLOWMETER BYPASS VALVE

A bypass valve has been devised which offers substantial benefits when installed in a turbine flowmeter system with a range from 4 to 70 gallons a minute. When the valve is actuated following complete system cooldown, the indicated flow rate immediately drops from 70 to 10 gallons per minute.

Commercial application of this idea should prove valuable in the area of piping components and techniques, or cryogenic technology, all of which have wide industrial use. Weight is considerably reduced, while reliability and accuracy of the flowmeter are safeguarded since design limitations are not in-



volved. The time required to load propellants is decreased, and cryogenic liquid can be admitted to the system at the normal fill rate, thus shortening the cooldown phase. Several factors contribute to cost reduction: the discarding of numerous valves or one large multiposition valve; the reduction of loss by removing much of the mass and so decreasing heat leak and cooldown time; and the elimination of damage to delicate bearings, thus saving material replacement and labor costs.

To adequately safeguard a flowmeter would require several valves with elaborate plumbing or an expensive multiposition valve, either of which would be heavy and bulky. A survey of several flowmeter companies indicates that the new device is unique in its field. Since weight, reliability, time, and cost are prime factors in space vehicles, a small, inexpensive bypass valve would allow high-velocity gas to flow around the meter and then, once the system was cooled, would permit liquid flow through the meter. The subject valve was designed and met its requirements.

Source: Douglas T. Covington of
Martin-Marietta Corp.
under contract to
Marshall Space Flight Center
(MFS-12864)

Circle 3 on Reader's Service Card.

Section 3. Valves for Extreme Conditions

LEAK-TIGHT SHUTOFF VALVE FOR HIGH PRESSURE SYSTEMS

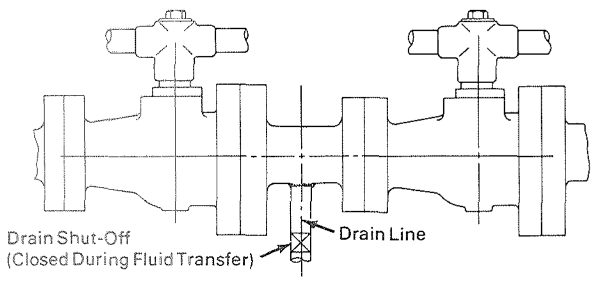


Figure 1. Two Valves in a Series (Old Method)

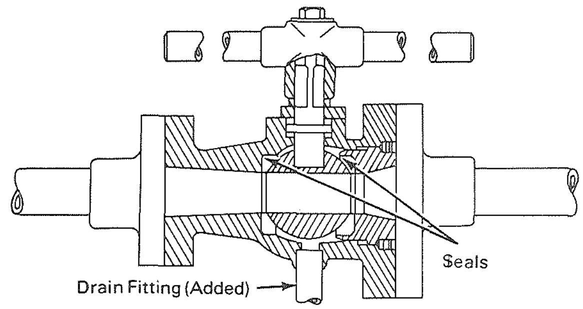


Figure 2. Single Valve Modified with Drain Line (New Method)

A new and simple ball valve has been evolved which is suitable for use in high pressure systems or where temperature extremes are encountered.

Previous methods of ensuring leakproof operation of double-seal ball-type shutoff valves involved drawbacks and complications. At low temperatures (such as during transfer of cryogenic fluids), the contraction resulting from extreme cold caused leakage past the seals. The old method of solving the problem (Fig. 1) was to install identical valves in series, separated by a short length of tubing which acted as a residual drain line.

The same result is now obtained more simply (Fig. 2) using only one valve with minor modification. A residual drain line is fitted to a hole in the valve housing below the ball shutoff and between the two seals. Any leakage beyond the first seal is bled off through the drain line. Leakage can occur past a shutoff valve under a variety of extreme conditions affecting the seal. This method effectively relieves the ball valve of these stresses.

Source: H.C. Brittian of
General Dynamics Corp.
under contract to
Lewis Research Center
(LEW-90396)

No further documentation is available.

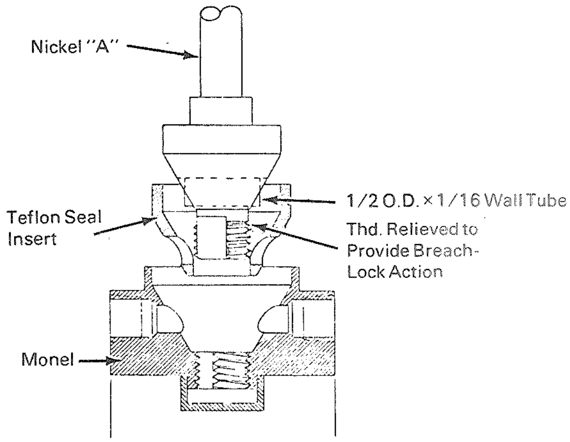
ABRASION- AND RADIATION-RESISTANT DISCHARGE VALVE

A new type of valve has been developed to withstand intense radiation and high abrasion, together with the heat transfer rates encountered in reactor application.

Essentially, the device consists of a discharge valve with a straight-through port (to permit occasional rodding of a caked bed). The valve has a replaceable Teflon seal which offers natural lubricity. There is only one moving part, designed for remote assembly or disassembly.

The body of the valve (see fig.) has a conical recess and a mating conical plug. A Teflon insert is located between these two sections and can be replaced before each new closure of the valve. This helps minimize the damaging effects of abrasion as well as those of the radiation and elemental fluorine encountered in the original application. Screw threads at the apexes of the cones drive the peg into the seat for valve closure. When opened, these threads produce a clearance which minimizes scoring of the valve seat by alumina.

The cylindrical sections at the bases of the cones provide an auxiliary seal during discharge. The breach-lock cutaway allows rapid assembly and disassembly with a single manipulator. To prevent



independent rotation of the seal, a tube is inserted into the plug from which it protrudes. The tube drives the Teflon seal with the plug. Since abrasive wear in valves is a common industrial problem, the remotely replaceable seal offers cost savings and reduction in maintenance.

Source: W.L. Gottwald
Argonne National Lab
(ARG-10219)

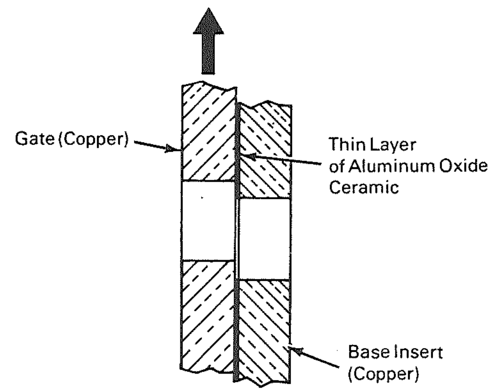
Circle 4 on Reader's Service Card.

CERAMIC-COATED, HIGH TEMPERATURE GATE VALVE

A new gate valve (see fig.) has been designed to prevent binding (or welding) between the gate and base surfaces while these are exposed to a very rapid sliding action of about five milliseconds in duration. The necessary protection is provided by a ceramic coating which eliminates the high risk of frictional binding and poor reliability during sliding contact in high-temperature environments. This improved valve should find many new uses in connection with industrial machinery, since it offers an important advantage over conventional gate valves which normally incorporate brass, copper or stainless steel gates. In a high-temperature environment of 4000° to 5000°F, these gates need replacement after each closure, but with a ceramic coating they last for long periods and are then easily replaced.

A renewable base insert of copper is used, which is coated with a thin layer of aluminum oxide ceramic on the surface that comes into contact with the gate. The ceramic coating is accomplished by spraying an alumina preparation (activated, powdered catalyst AL-0102P-98% Al_2O_3) to a depth of approximately 0.008 inch. The coating is then ground down to 0.005 inch and the insert positioned with the aluminum oxide surface facing that of a copper gate in the valve. The thin film of aluminum oxide ceramic has negligible effects on the heat sink characteristics of the copper base and gate, yet prevents "welding" of the surfaces during the sliding action in five-millisecond valve closures at temperatures as high as 5000° F.

Because the thin ceramic coating is highly resistant to cracking or chipping, it requires replacement only after it deteriorates from ablation. Replacement of the coating is simple. The base insert is removed from the valve and resurfaced with aluminum oxide after the worn-out surface has been ground away.



Source: Abraham Brass
Ames Research Center
(ARC-90023)

Circle 5 on Readers' Service Card.

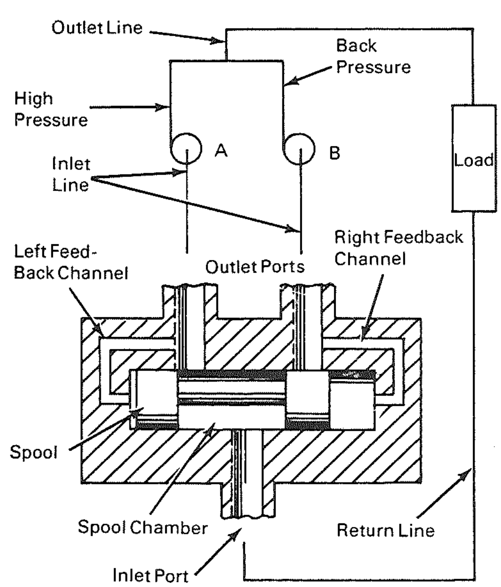
Section 4. Safety Valves

SELF-ACTUATING, DOUBLE-ACTION VALVE

The self-actuation, double-acting check valve shown in the figure is, in effect, a servo system operating on a pressure differential. In the event of pump failure the valve provides continuing fluid flow through a redundant system. This disclosure has obvious applications in any industrial area where total operating reliability with fluids (gas or liquid) can provide continuity of action in the event of pump failure.

The valve features a spool located in a cylindrical chamber. Two parallel outlet ports are so spaced that movement of the spool can close only one port at a time. The valve body also includes a pair of opposed feedback channels and an inlet port leading from the system load.

When pump A is operating, low pressure develops along the inlet line and high pressure in the outlet and through the load and return line. Low pressure also develops along the feedback line of pump A. Since pump B is not operating, back pressure is applied through its outlet line from the outlet of pump



A. High pressure also builds up on the inlet line of pump B which is reflected into the right-side feedback line and the spool chamber. The pressure differential on opposite ends of the spool chamber keeps the spool to the left.

Failure of pump A causes a pressure switch circuit (not shown) to sense reduced output. The switch thereupon starts pump B and a reverse process begins. Since a pressure differential develops with either pump operating, the loop containing the inoperative pump automatically closes, avoiding a fluid short circuit.

Source: D.M. Wright of
International Business Machines Corp.
under contract to
Marshall Space Flight Center
(MFS-13335)

No further documentation is available.

SHUTTER VALVE

A shutter valve has been designed which offers promising industrial applications in practically all fields where air- and fluid-circulating systems are used. Several advantages are claimed, including rapid operation for size; compactness; simplicity of control; sealing in various sized containers depending on component design; and an operating temperature range from −10°F to +1000°F. An added advantage is that in the event of control failure the valve will operate on backflow.

This valve consists of a series of blades mounted vertically on shafts. The shafts rotate by means of a clevis, link-and-pushrod assembly. The pushrod is moved horizontally by a single-action, gas-driven cylinder. Gas is supplied from a storage accumulator and released via an explosive valve. An electrical signal operates the valve. On release of gas, the pushrod is accelerated rapidly to close the valve in 0.065 second. If the force were constantly applied, it would damage the blade assemblies. A hydraulic shock absorber is therefore used to decelerate the system within a short distance. The blades seat against asbestos seals mounted on the shafts and gasket retainers to keep leakage at a minimum.

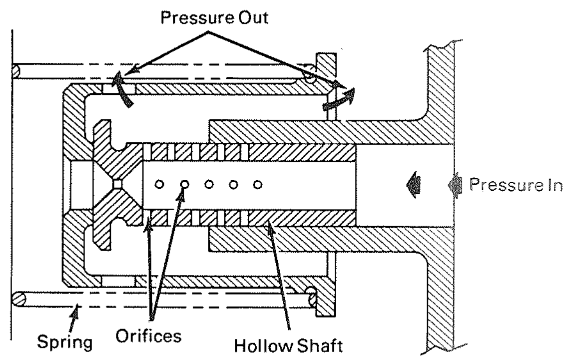
The valve is reopened by a small, manually controlled gas cylinder. The entire assembly is encased in a box-like steel structure in which are mounted various seals and bearings capable of withstanding high vacuum at a temperature of 1000°F for its designed 20-minute period of operation.

Source: N. Rothmayer, C. Kastner, Jr.,
L. Burton, and H. Sassong of
Thiokol Chemical Corp.
under contract to
Manned Spacecraft Center
(MSC-91159)

No further documentation is available.

VARIABLE-PRESSURE ORIFICE FOR HYDRAULIC CONTROL VALVE

The design of a hydraulic valve with a variable pressure orifice makes it possible to impact two large bodies without jarring shock. Such an impact presents at least one major problem related to the controlled release of energy. The subject disclosure, therefore, has a wide potential of applicability in heavy industry where shock is generated by the release of pressure. Shock inevitably shortens the life of the impacting components. Stamping mills and earthmoving equipment are prime examples.



The basic principle upon which this device operates is that the area of exit porting to the control fluid is directly proportional to the area of the pressure head acting upon the fluid. Previously, hydraulic valves of various types have been tried, along with the use of tapered shafts mating with machined port exits. None of these has met the basic requirement of smooth contact.

Featured in the present disclosure is a hollow shaft with 12 or more orifices located along its wall which is lap-fitted to a mating sleeve, as shown in the figure. The closed end of the sleeve is attached to a spring-loaded receiver with large exit ports leading to a sump of ample dimensions. When the inlet pressure builds up in the shaft, it is forced forward in its sleeve as the tension of a restraining spring is overcome. Movement of the hollow shaft in the sleeve opens an increasing number of orifices to the exit ports. In this way, high pressures are smoothly controlled, and conversely, a limited flow occurs at low pressures.

Source: Robert L. Ammerman of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-11323)

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)] to North American Rockwell Corp., 12214 Lakewood Blvd., Downey, California 90241.

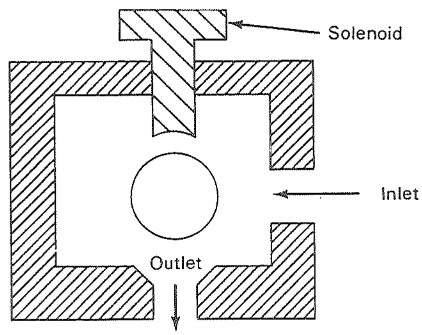
No further documentation is available.

SOLENOID-OPERATED VALVE HAS NO SEALS

A solenoid-operated valve which needs no seal fills an important commercial need in the petroleum, chemical, plastics, electronics, and automobile industries.

The attendant hazards of a valve seal, brought on by temperatures, pressures and the nature of the fluids in which the valve may operate, have been resolved.

An energized solenoid, as shown in the figure, lifts the ball off the valve seat and allows pressure to flow through. When the solenoid is de-energized i.e., when current is cut off, the inlet pressure forces the ball against the seat to stop the flowthrough of the valve. Since no valve seals are required, the seal-medium compatibility problem is eliminated.



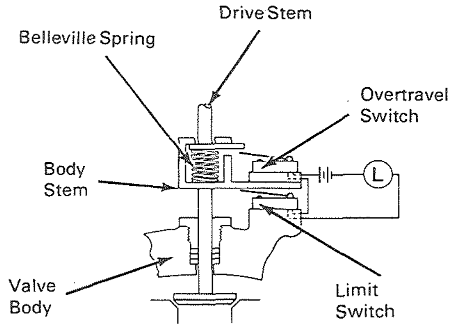
Source: Murl L. Dozotell of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-92006)

No further documentation is available.

CLOSURE SENSING DEVICE

This device indicates whether a poppet valve located in a remote area is completely closed. The opening may be one intended for fluids, solids, or gases. Industrially, the device provides a safety feature for ensuring the closure of a specific opening. Remote sensing, however, will not function if an obstruction occurs between the plug and the seat of the valve. This improvement permits a higher confidence rate in poppet seating. It consists of two contact switches that will complete a circuit and transmit a signal only when the poppet is seated.

An overtravel coil or special spring is positioned between the upper drive stem and the lower body stem (see fig.). A limit switch is adjusted to close when the plug is almost touching the seat. The overtravel switch, in series with the limit switch, closes when adequate pressure is exerted between the seat and the plug. The light will go on only if both



Limit Switch—Set to Operate at 1/16 Inch or Less Off Seat.

switches are closed. If an obstruction exists between the plug and the seat, the limit switch will not make contact, even though the overtravel switch is closed.

Another method (not illustrated) is to make the seat in two sections so that the seating-surface piece is free to move up and down slightly in relation to the stationary threaded portion. A strain gage is imbedded in a compressible material in this recess. The change in reading of the strain gage caused by the pressure of the plug forcing the two segments of the seat together is used as the signal of closure. The signal may be amplified to operate lights or audible devices.

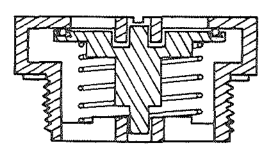
Source: Chester S. Beard of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-92038)

Circle 6 on Reader's Service Card.

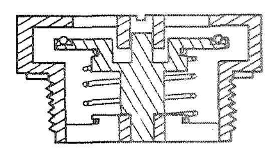
VACUUM PREVENTION VALVE DESIGN

This modified breather valve is designed to protect the structural integrity of a piece of equipment from damage where internal pressure drops below that of the atmosphere. It should therefore prove useful in averting negative pressure buildup inside a tank, for instance, (with resultant operational breakdown) in case of a leakage caused by fracture or some other problem. The valve, which is lightly loaded at all times, closes automatically with an application of minimum purge pressure. It will not then reopen unless there is a loss of purge gas supply and a resultant drop in pressure to nearly that of the atmosphere.

The modification is extremely simple. It consists of replacing the compression spring in the breather valve with a light tension spring (see fig.). A normally open condition is then achieved and the spring is so designed that only a tank pressure flow will



Before Modification



After Modification

close the valve. Conversely, an internal pressure drop will open it, regardless of the cause. Within the limits of capability of the valve, therefore, the result is free breathing in either direction with the advantage of a one-way automatic control.

Source: Lowell Sisson of
North American Rockwell Corp.
Marshall Space Flight Center
(MFS-92015)

Circle 7 on Reader's Service Card.

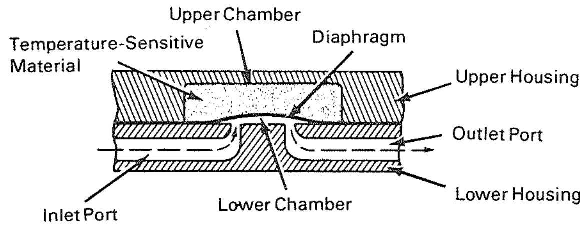
TEMPERATURE RESPONSIVE VALVE USES THERMOSTATIC PRINCIPLE AS A SAFETY MEASURE

A valve has been designed which can regulate the flow of a fluid over a wide temperature range while dispensing entirely with mechanical means. Application of a thermostatic principle enables the task to be performed effectively and simply.

Industrially, one of the prime functions of such a valve would be to protect sensitive equipment to which it was connected, by setting a definite temperature ceiling on the fluid passing through. The valve is made up of an upper and lower housing (see fig.), with the upper housing containing a cavity while the lower housing contains inlet and outlet ports.

Dividing the two housings is a thin, lightweight diaphragm which, at the same time, seals off temperature sensitive material in the upper housing cavity. Silicone rubber makes a highly suitable temperature-sensitive material that has the ability to expand or contract in a predetermined manner, in response to temperature changes.

The thermostatic action of the valve comes into operation when the incoming fluid, passing through the inlet port, causes the temperature-sensitive material to contract or expand. In turn, the diaphragm moves up or down, either opening or re-



stricting the passage between the inlet and outlet ports.

Source: Marshall B. Gram of Jet Propulsion Laboratory under contract to NASA Pasadena Office (NPO-10186)

Circle 8 on Reader's Service Card.

SOFT-SEAL SAFETY VALVE FOR HAZARDOUS FLUIDS

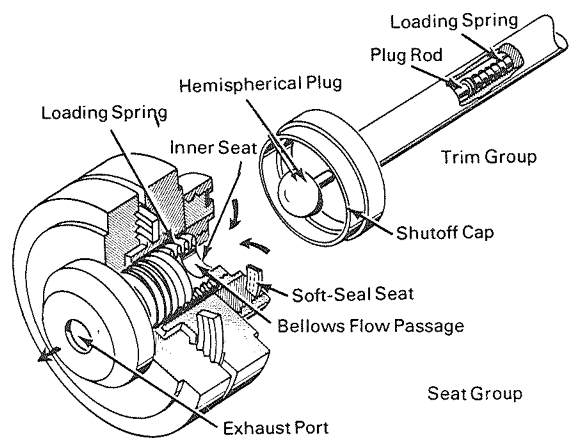
An improved valve assembly which includes a plug to block bulk flow and a soft-seal outer seat appears to have solved the problem of handling corrosive and other hazardous fluids. The seat effects zero-leak stoppage.

The valve is made up of a seat group and a trim group (see fig.). The (hemispherical) plug is located in the trim group, together with a loading spring which engages the plug rod and a stainless steel, circular shutoff cap with a relatively sharp edge.

The seat group consists of an inner stainless steel seat opening into a bellows flow passage shaped to receive the hemispherical plug, plus a soft-seal circular seat. The stainless steel shutoff cap fits into this seat.

During operation, the fluid flow is directed past the trim group, through the stainless steel seat and bellows flow passage to the seat group exhaust port. As the trim group moves forward, the spring-loaded hemispherical plug contacts the stainless steel seat and shuts off the bulk of the fluid flow. Continued forward movement of the trim group brings the stainless steel shutoff cap into contact with the soft-seal circular seat, completely closing the valve. Fluid trapped between the shutoff cap and hemispherical plug gradually gasifies and vents to the downstream side of the valve assembly through the rough seal formed between plug and stainless steel seat.

The initial seal (which permits downstream vent-



ing) is accomplished by: 1) spring loading the inner seat; 2) designing the annular surface area of the inner seat with a larger surface than the cross-sectional area of the bellows flow passage. Downstream venting of any fluid trapped in the bellows cavity takes place through vent holes drilled through the inner seat.

Tests have shown that a number of soft-seal materials are suitable for this valve. Tetrafluoroethylene is common to all these materials, but various metal fillers and even a glass filler can successfully be combined with it. When tested with liquid fluorine, this device is acceptable at flow rates of 2 pps with inlet pressures to 97 psi absolute.

Source: Lewis Research Center (LEW-90275)

Circle 9 on Reader's Service Card.

INTEGRAL VALVE PROVIDES AUTOMATIC RELIEF AND REMOTE VENTING

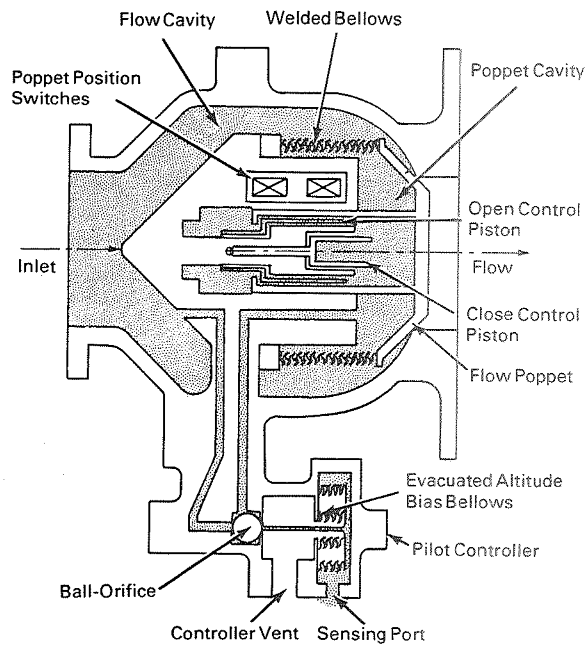
A dual mode integral valve package has been designed that performs two important functions: 1) it provides automatic relief of a tank at a precise over-pressure; and 2) it also provides remote control of tank venting. The valve is capable of offering fast relief response within a temperature range of -270° to +260°F at high pressure rise rates of up to 40 psi/sec.

This equipment, because of its wide operational temperature range, offers great promise in a variety of industrial uses, including petrochemical processes and refrigeration. Incorporated in an integral package is an in-line pilot-operated, differential area poppet valve with separate relief and vent operations. Automatic tank relief results from differential pressure conditions, while the application of control pressure provides rapid remote control of the tank venting operation.

In the relief cycle (see fig.), as the tank pressure monitored at the sensing port exceeds the preset calibration pressure of the bias bellows, the pilot plunger strokes the ball off its seat. This action relieves pressure in the poppet cavity and dissipates it in the atmosphere. As the ball closes off supply pressure, the poppet cavity bleeds down rapidly. The unbalanced force caused by differential pressure between the flow and poppet cavities moves the flow poppet to an open position, thus providing tank relief. A reverse process closes the flow poppet as sensing pressure is decreased by the relief operation.

During the vent operation, the flow poppet is opened by the remote application of pressure to the open control piston. The flow poppet is closed by mechanical spring force of the welded bellows when control pressure is applied.

Where faster or redundant valve closing is required for the vent operation, a "force close" (gas piston) feature is provided. Full open or full closed flow poppet position indicator switches permit remote monitoring of the valve operation, with the following vent response times: full open time of 0.4 sec maximum at 44 psig system pressure with a temperature range of ±200°F. Closing time of 0.5 sec nominal, or 1.0 sec at -270°F. The internal leakage rate (across all dynamic seals) is less than 50 standard cubic inches per minute of helium between -300°F and +260°F. External leakage rate (with helium) is zero at 45 psig.



Source: R.F. Gilmore of
Chrysler Corp.
under contract to
Marshall Space Flight Center
(MFS-12134)

No further documentation is available.

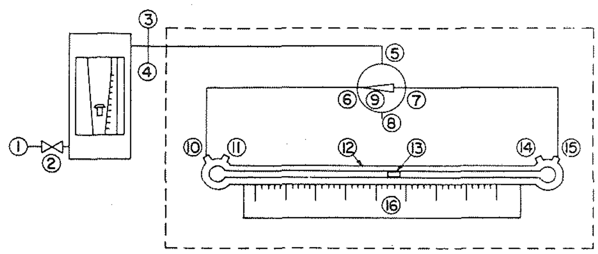
Section 5. Special Applications

VOLUMETRIC MEASURING DEVICE

The purpose of this device is to measure gas volume and the low-flow rates. It would therefore be useful in calibration and testing laboratories and to industries manufacturing low-flow gas measuring equipment.

A precision bore glass tube is horizontally affixed to a backup plate (see fig.). Welded to each end of the tube is a small glass bulb with two ports: the port on the right end is a vent, while the port on the left end permits a reverse flow of gas to drive a mercury piston back into starting position. If the mercury piston is overdriven, it rolls into the glass bulb on the end of the tube.

A three-way valve is mounted to the bench. This arrangement facilitates hooking up the instrument for calibrating, venting, and gas flow measurement. A metal scale is mounted adjacent to the tube. With the flow-measuring instrument to be calibrated in its operating mode, the gas is directed through the instrument into the inlet port of the three-way valve. The valve is in vent position. After the flow to be measured is established, the valve is turned to the measuring position, directing the flow into the glass tube. Any suitable timing device can



1 Gas Source
2 Control Valve
3 Pressure Port
4 Temperature Port
5 Valve Inlet Port
6 Valve Measure Port
7 Valve By-Pass Port
8 Valve Vent Port
9 Three Way Valve
10 Tube Inlet Port
11 Tube Pressure Port
12 Precision Glass Tube
13 Mercury Piston
14 Tube Vent Port
15 Tube By-Pass Port
16 Scale

be used to time the piston movement throughout the volume to be measured. Given the volume, time, pressure, and temperature, the flow rate can be calculated.

Source: T.U.B. Valdez of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-91330)

No further documentation is available.

INDIRECT VALVE TIMING: A CONCEPT

An improved conceptual approach to determine indirectly the rate of operation of a series of hydraulic valves appears to offer great potential. By providing a means of recording pressure versus time and of indicating the actual motion of the valves, this concept suggests new commercial applications in many areas where time-controlled, valve-sequencing operations are required. Such areas include the petrochemical, food processing and pharmaceutical industries.

The proposed new technology eliminates the usual position indicators and conduits. The required parts are (1) a single pressure transducer at each control manifold (see Fig. 1) to produce individual valve traces, and (2) centering springs in

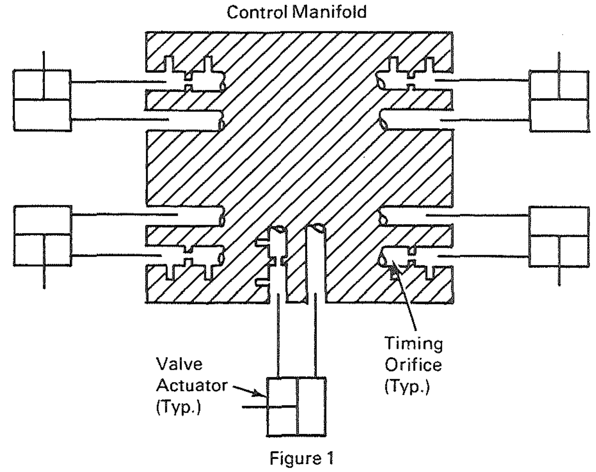


Figure 1

the flow indicator which have spring rates unaffected by low flow or by valve motion due to leakage. Using available lines for normal operation, the valve timing is accomplished during actual valve movement, when the pressure differential resulting from flow through the timing orifice causes the valve to move. Fluid flow is then ported into the manifold in series. A measurable pressure is thus created as a function of valve travel. The pressure transducer now has pressure level as a function of the flow indicators which have ported the fluid into the manifold. The slide valve senses flow in either direction, indicating either valve opening or closing as in Figure 2.

Source: Lloyd E. Tomlinson of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-18369)

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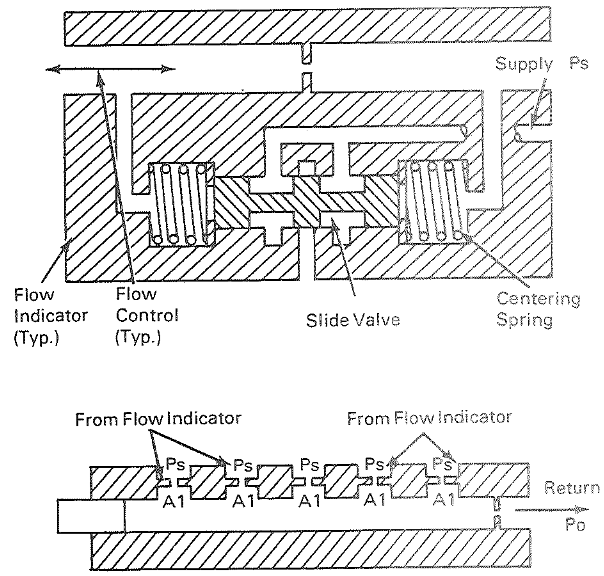


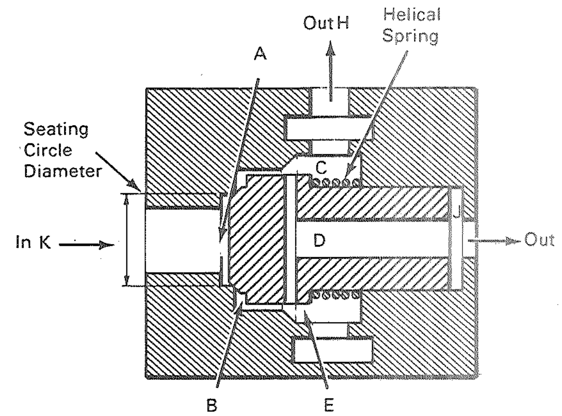
Figure 2

DYNAMICALLY STABLE CHECK VALVE FOR WIDE FLOW RANGE: A CONCEPT

This concept of a poppet-type check valve design is intended to accommodate a wide flow range without the usual chatter problems at low flow conditions. The figure relates to a proposed pressure isolation check valve with dynamically stable properties, which should find ready use in pneumatically controlled heavy industrial equipment, earth moving equipment, and metal forming presses.

Given line contact between the poppet and its seat, the seating circle is defined by the indicated seating ring diameter. Acting against the poppet in its opening direction are internal pressures indicated by A and B. Internal pressures acting in the closing direction of the valve may be noted at C, D and E. A helical spring with a predetermined installed load and spring rate applies a closing bias force. The spring installed load divided by the poppet seating circle cross-section area is equal to 10 psi.

Assuming outlet pressures at H and I are equal, when these outlet pressures drop more than 10 psi below inlet pressure, the poppet unseats, permitting gas flow through the check valve. As the poppet unseats, annular clearance around its circumference presents a flow restriction. This reduces sharply at about one half the poppet stroke. The restriction results in an internal pressure at J which



is greater than C under flow conditions. As the poppet cracks and flow begins, the resultant unbalanced force exerted by pressure J becomes an accelerating force in the opening direction

With the poppet fully stroked, the flow area through the clearances between the poppet and the seat and housing are between two and three times the cross-section area of the inlet port. At this point, the major pressure drop is from inlet pressure K to internal pressure A.

Under flow conditions, when the pressure drop from inlet to outlet is slightly more than 10 psi, the poppet opens, pressure A decreases below K, the pressure across the poppet drops below 10 psi, the poppet closes and cyclic operation results. During each opening of the poppet, pressure B exerts an opening acceleration force which does not remain as a significant holding down force. This is due to the flow area transferring from the poppet to the inlet port. Under flow conditions, the pressure drop from inlet to outlet required for holding the poppet in its fully open position is greater than that required for cracking the poppet from its seat. Since there is no significant dynamic dampening of the poppet, cyclic operation will accompany any flow demand which can be satisfied with an overall pressure drop less than that required for a fully open poppet.

Source: J.G. Absolom of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14579)

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LOW POWER INPUT FLUID CONTROL CIRCUIT

This disclosure relates to a standard, commercially available electromagnetic relay that switches a fluid amplifier. This amplifier, in turn, drives a spool valve which actuates a fluid control circuit. The basic idea is not new, but the fact that it can now be done with low level (as opposed to high power level) electrical signals is of considerable importance since it greatly broadens the industrial value of this type of valve.

In operation the relay contacts are replaced by nozzles connected to the control ports of a bistable fluid jet amplifier. The spring loaded armature of the relay covers one nozzle (Figure 1) or the other (Figure 2) as the relay is activated and deactivated. The fluid jet amplifier controls the spool of a mechanical valve handling relatively high volumes and flow rates. An important benefit is that the power requirement for the electromagnetic relay is only 10 milliwatts, or 1000 times less than the 10 watts required by a solenoid in the same application.

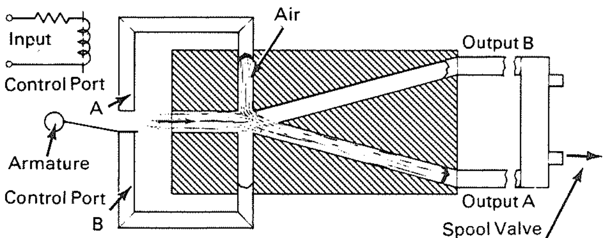

Figure 1

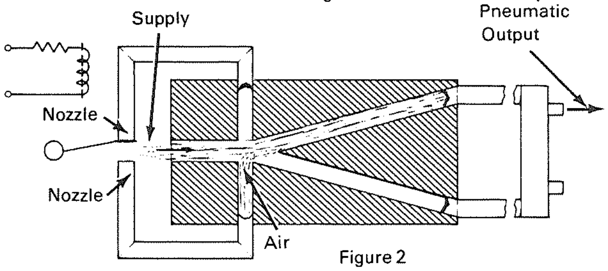

Figure 2

Source: Vern Gebben
Lewis Research Center
(LEW-90325)

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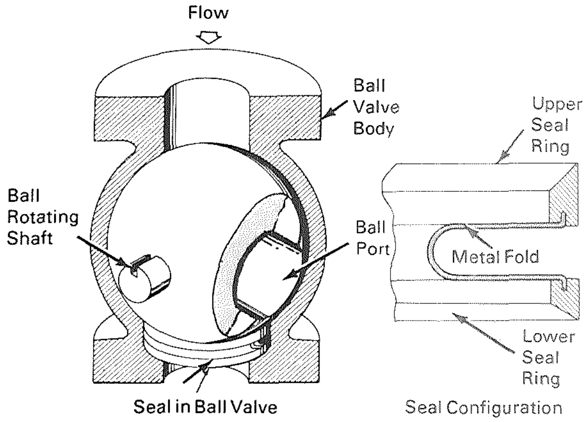
Section 6. Leakproof Designs

PRESSURE-RESPONSIVE SEAL HANDLES STATIC AND DYNAMIC LOADS

A line pressure responsive double-acting seal (see fig.) has been evolved for ported ball valves which should solve the leakage problems encountered by industry with existing equipment. It should also be useful where fluids under varying pressures are transferred in random quantities.

Conventional seals using fluid pressure are effective on ported ball valves mainly under static conditions. Single seals for operating under both static and dynamic conditions have used a sliding seal between the valve housing outlet and ported ball. Here a spring loads the sealing ring against the ball. Under load, the effective pressure limit is directly related to the tensile strength of the spring.

The top of the seal engages the ported ball at the outer circumference of the seal's upper end. The bottom of the seal seats on a flat circular land with a continuous wall, similar to a counterbore. The seal consists of plastic upper and lower rings bonded to the opposing lips of an inwardly projecting fold of metal. The fold serves two purposes: it forms an annular passage for free flow of fluid when the ball valve is in the port-open position; and it also acts as a spring to keep the seal surfaces in intimate contact with the ball and body land in the port-closed position. As pressure increases, the ball compresses the seal against the land and the soft plastic faces of the seal fill any irregularities in either ball or land. As pressure drops in the port-closed position, the metal fold acts as a spring and keeps the plastic rings in firm contact with ball and land.



In this position the tension exerted by the metal fold on the plastic rings is directly proportional to the pressure of the fluid acting upon it.

Source: H.W. Marsh of
North American Rockwell Corp.
under contract to
Goddard Space Flight Cener
(GSC-90441)

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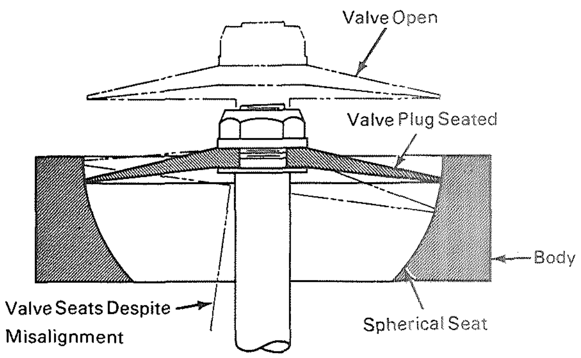
VALVE SEALING WITH MISALIGNED STEM

A continuous and effective valve seal is provided by a conical valve plug, sealing against a recessed spherical valve seat. The effect of this device on industrial problems, aggravated in the past by repeated malfunctions, should be considerable. It formerly sufficed for the valve stem to be slightly out of alignment to cause a sealing problem, but this is no longer the case.

The subject improvement has the basic advantage of simplicity. A conical-walled valve plug (see fig.) which provides an effective sealing element is mounted on the end of a valve stem and held in position by a nut and washer. The cross section of this valve plug is shaped like a shallow cone. When the valve is closed, the circumference of the cone contacts the valve seat. Because the valve has a recessed seating face (formed like a sphere), it will seal effectively even though the stem may be out of axial alignment. Thus, the conical-walled valve plug is perpendicular to the tangent of the spherical seat at the point of contact, regardless of the position of the stem. The uniform diminishing thickness of the conical valve plug contributes



to the sealing action. Many hundreds of opening and closing cycles are assured, while the design also allows the ultimate in mechanical advantage from forces applied to the valve. No deformation of the spherical valve seat or the conical plug face is possible, since the design eliminates unequal distribution of forces at the interface.

Source: Harold W. Schmidt
Lewis Research Center
(LEW-90038)

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ELASTIC SEAT VALVE

A ball-and-pintle valve has been developed, entirely of metal, with its seat relieved sufficiently to provide the needed elasticity during closure. By providing both tight conformity of the seat to ball irregularity and a scrubbing or wiping action which eliminates minute particles, this valve offers greatly enhanced reliability and efficiency from an industrial standpoint.

Ball-and-pintle valves normally feature either a seat or a closure device made of a material–such as rubber or plastic–which deforms during closure to prevent leakage. The drawback, however, is that plastic components deteriorate under repeated use.

The body of the new valve is machined with an axially annular channel (Fig. 1) surrounding the outlet passage. This channel effectively changes the passage into a thin, tubular seat member. Surrounding the seat member is an annular backup ring with an inside diameter slightly greater than the external diameter of the tubular seat and an outside diameter slightly less than that of the channel. This ring serves as a retainer around the seat so that it cannot expand beyond its elastic limit during valve closure. The tubular seat is

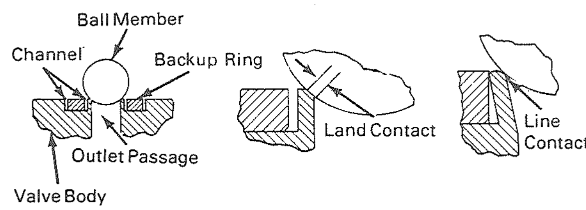

Figure 1 Figure 2 Figure 3

spherically lapped so that upon contact, the ball closure elastically conforms to the ball surface and makes a radial land contact (Fig. 2). As the ball is driven further down, the tubular seat is forced radially outward (Fig. 3). At this point, the ball makes only a radial line contact, but this suffices for absolute closure. Between these two points, the scrubbing or wiping action removes any minute particles that might otherwise cause leakage.

Source: W. F. MacGlashan Jr. of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-90442)

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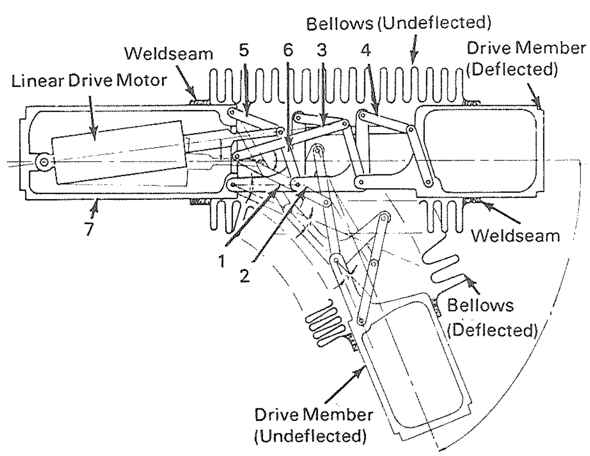
HERMETICALLY SEALED ELBOW ACTUATOR: A CONCEPT

The object of this concept is to provide for an electrical or hydraulic means of hermetically sealing an angular or rotary actuator over a range of $\pm 180°$.

Usually, under hostile environments encountered in space, in the ocean, or under strong chemical exposure, the endurance of dynamic seals is limited by the relative motion of bellows-type flexural members.

The substitution of metal enclosures (stainless steel belows) is restricted by small deflection which limits the angular changes of the actuator. The concept, therefore, is to provide incremental flexures that will keep local deflector rates within limits.

As shown in the figure, mechanical linkage allows complete enclosure of the actuator within hermetically sealed bellows. This arrangement can produce total angular deflection by incre-



ments, within the capacity of the bellows. The angular multipliers 1 and 2 in the figure are guided by the blind actuator rods 3 and 4. The linear drive motor moves the linkage between arms 5 and 6. The motion rotates multiplier 1 over an angle χ, compatible with the elasticity of the bellows. Blind actuator rod 3 causes angular rotation of multiplier 2 over an additional angle of β, increasing the deflection α. Blind actuator rod 4 rotates the driver member over the angle γ, which is then deflected relative to member 7 by the sum of the incremental deflection α, β and γ, to a total deflection ϵ.

The addition of angle multipliers to the joint provides deflections of more than $\pm 180°$ in plane; or continuous spiral, rotation can be achieved by adding single multipliers to the joint, all of which are actuated by the linear motor. Deflection rate between angular multipliers can be varied by changing the proportions of the blind actuators. Even the curvature can be incrementally changed between angular multipliers to achieve desired geometry of the total bend. Movement of the drive member also is possible while operating the actuator.

Source: H. F. Wuencher
Marshall Space Flight Center
(MFS-14710)

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